AFRICAN FORUM
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The influence of environmental factors and socio-economic status on urban residents' experiences of and vulnerability to ecosystem disservices, in four cities of South Africa

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Introduction

Climate change is a serious threat worldwide

Need for green spaces (GS)/GI, especially in urban areas:

1. The future of humanity **will be largely urban**, with an expectation that 70 % of people will live in urban areas by 2050 (United Nations, 2019)
2. Urbanisation is **key contributor to CC and pollution in developing countries**
3. **Importance of GS** for delivery of a wide range of ES (e.g. climate regulation, improvement of air quality, recreation) (Kabisch et al., 2021)

Green spaces: "all urban land covered by vegetation of any kind" (World Health Organization, 2017)
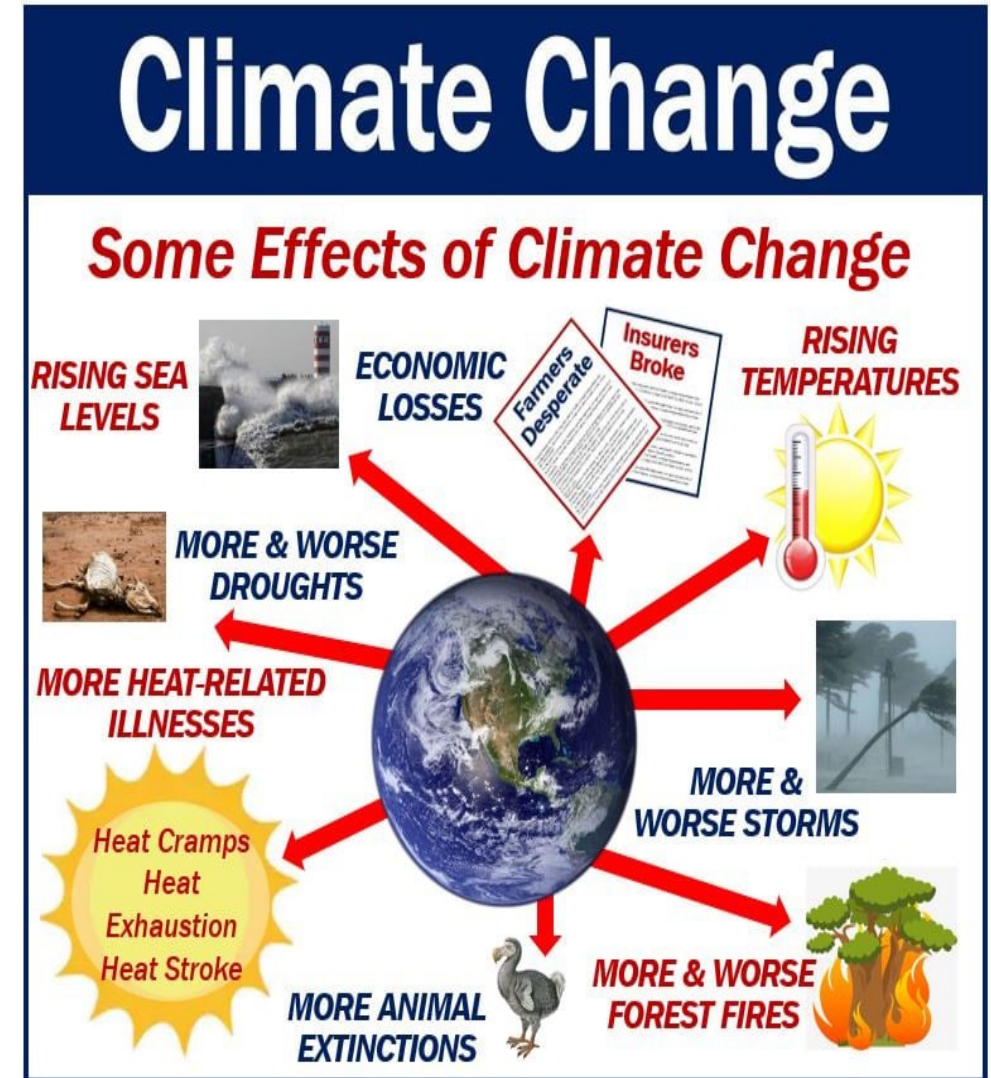
Introduction

Ecosystem services: tangible and intangible goods and services, or benefits derived from nature (ES; MEA, 2005)

Ecosystem disservices (EDS) are a reality (von Döhren & Haase, 2022)

EDS: "the ecosystem-generated functions, processes and attributes that result in perceived or actual negative impacts on human wellbeing" (Shackleton et al., 2016)

The "supply" of many EDS can be very irregular; some occur as minor nuisances, only becoming a major concern when they build up or have large impacts

However, even minor EDS can undermine peoples' perceptions of the ES, if not well handled. Also, EDS in urban areas scored higher than ES.

Introduction

Overall, the impacts of EDS depend on their nature, severity, prevalence and peoples' ability to cope, hence on culture and context (von Döhren & Haase, 2022; Cox et al., 2018).

Therefore, peoples' reported vulnerability to specific EDS may be influenced by their socio-economic conditions, including environmental attitudes and experiences

Such variations in perceptions and experiences of EDS need to be better understood for their effective inclusion into ecosystem management strategies

Objectives

To assess:

(i) the nature, prevalence and experiences of urban EDS

(i) how these vary across socio-economic and environmental strata

(ii) differentials in urban residents' vulnerability to different EDS

It aligns with **Goals 1 and 7 of the Africa Union Agenda 2063**, particularly to the targets related to climate resilience and modern and livable habitats:

1. By guiding improved and optimal design and management of green spaces that are much needed in urban areas in the context of climate change and other environmental challenges

2. By helping identify factors of vulnerability to EDS and guiding policy decisions in terms of actions to reduce the existence of these factors within communities, and thus limit vulnerability (or improve coping ability of urban dwellers) to EDS

Methods

Study area: Eastern Cape province of South Africa
- Alexandria and Port Alfred both close to the coast in the Albany Thicket biome
- Adelaide and Cathcart, further inland, within the grassland biome

Randomization was achieved via random points generated using GIS on Google Earth images of each town (Howell et al., 2020)

Questionnaire survey of 303 adult respondents in random households in 03 neighborhoods of different economic standing:
- The RDPs (Reconstruction and Development Programme) neighborhoods are social-housing areas established by government post democratic transition in mid-1990s and made available to indigent people: poverty levels are typically high

- The township neighborhoods pre-date the RDP Programme and were areas zoned for occupation by Black South Africans under the previously racist apartheid political dispensation. Typically, houses were built by their owners and there is generally a wide range in mean household incomes

- The affluent neighborhoods, previously reserved for white inhabitants, but now with increasing numbers of Black households for those who can afford to buy there

Methods

Survey in one of isiXhosa, English or Afrikaans, depending on each respondent's preference

Collected data: (i) respondents' experiences of different EDS in different types of UGI (home gardens, streets, public green spaces, commonages), (ii) frequency and severity of experiences of EDS and coping ability (using a 3-point scale: high, medium and low), (iii) respondents' socio-economic characteristics, environmental attitudes, membership of environmental NGOs, possession of home garden, and visits to public GS

Socio-economic characteristics: neighborhood, age, years in town, highest education, gender, home language, upbringing, source of income and income range.

Environmental characteristics: membership of an environmental NGO, environmental attitude, ownership of home garden and frequency of visits to public green spaces

Respondents' environmental attitude: using level of agreement or disagreement to six statements (with 03 related to the health and sustainability benefits of GS and 03 to the negative influence of GS), using a Likert scale.

Scores for the statements related to the benefits of GS were as follow: 5=strongly agree, 4=agree, 3=neutral, 2=disagree and 1=strongly disagree. Inverted scores were used for statements related to the negative influence of GS

Methods

- List of EDS reported compiled
- Mean number of EDS per respondent determined and compared between the surveyed towns, using Kruskal-Wallis test (Quinn & Keough, 2002)

Analysis of influence of neighborhood on number of EDS per respondent within towns, using nested ANOVA

A Chi-square analysis used to assess potential relationships between experience of EDS per town and per neighborhood within towns.

Relationships number of EDS/respondent and socio-economic and environmental characteristics analyzed using Principal Component Analysis (PCA) (Filgueiras & Borges, 2021)

Number of EDS per type of UGI determined within towns and compared within towns and across neighborhoods, using a nested ANOVA

Vulnerability level via analysis of magnitude of experiences and coping ability

10 most reported EDS (by at least 5% of respondents across all towns) categorized, based on magnitude of their experience and ability to cope

Analysis of influence of socio-economic and environmental characteristics (SEEC) on respondents' magnitude of experience of EDS and coping ability, using PCA

Results and discussion

Nature and prevalence of ecosystem disservices (EDS) across urban areas

Prevalence of EDS significantly town-dependent (X^2=121.68; p<0.0001), with similarities between some towns for different EDS

Table 1. Urban ecosystem disservices experienced by >5% of the sample in at least one town

EDS	Adelaide	Alexandria	Cathcart	Port Alfred	Mean±STD
1. Roaming livestock making a mess or unpleasant smell in the streets	80.8	66.7	70.1	59.7	69.3±8.8
2. Rodents carrying disease, which is a risk to human health	32.1	17.3	53.7	27.3	32.6±15.4
3. Tree branches falling and damaging things or risk to people	12.8	19.8	32.8	11.7	19.3±9.7
4. Tree roots breaking pavements or walls, which poses a hazard to pedestrians	21.8	17.3	26.9	9.1	18.8±7.5
5. Trees blocking road signs or electricity lines	20.5	8.6	32.8	11.7	18.4±10.8
6. Phobias about certain species make me afraid	21.8	8.6	14.9	22.1	16.9±6.4
7. Pests and diseases that damage the plants I like to grow	15.4	14.8	10.4	22.1	15.7±4.8
8. Some birds making a mess on walls, windows, pavements	14.1	19.8	10.4	13.0	14.3±3.9
9. Trees or thick vegetation providing hiding spaces to criminals	10.3	16.0	14.9	10.4	12.9±3.0
10. Tree leaves/flowers/fruits falling and making a mess	10.3	12.3	9.0	5.2	9.2±3.0
11. Runoff during rains can flood or damage properties	5.1	2.5	16.4	11.7	8.9±6.3
12. Invasive plants taking space or water or outcompeting native species	3.8	4.9	13.4	10.4	8.2±4.5
13. Pollen, causing allergies	3.8	8.6	13.4	5.2	7.8±4.3
14. Soil erosion blocks drains and looks unsightly	2.6	1.2	13.4	6.5	5.9±5.5
15. Wildfires are a risk to properties and also life	2.6	0.0	20.9	0.0	5.9±10.1

EDS mentioned by < 5% of respondents: "Birds making excessive noise", "Insect or spider bites on humans", "Poisonous plants/fruits", "Tree blocking lights/views", "Snake bites on humans", "Uncared for vegetation", "Culturally taboo species" and "Thorns or prickles cause injuries"

Results and discussion

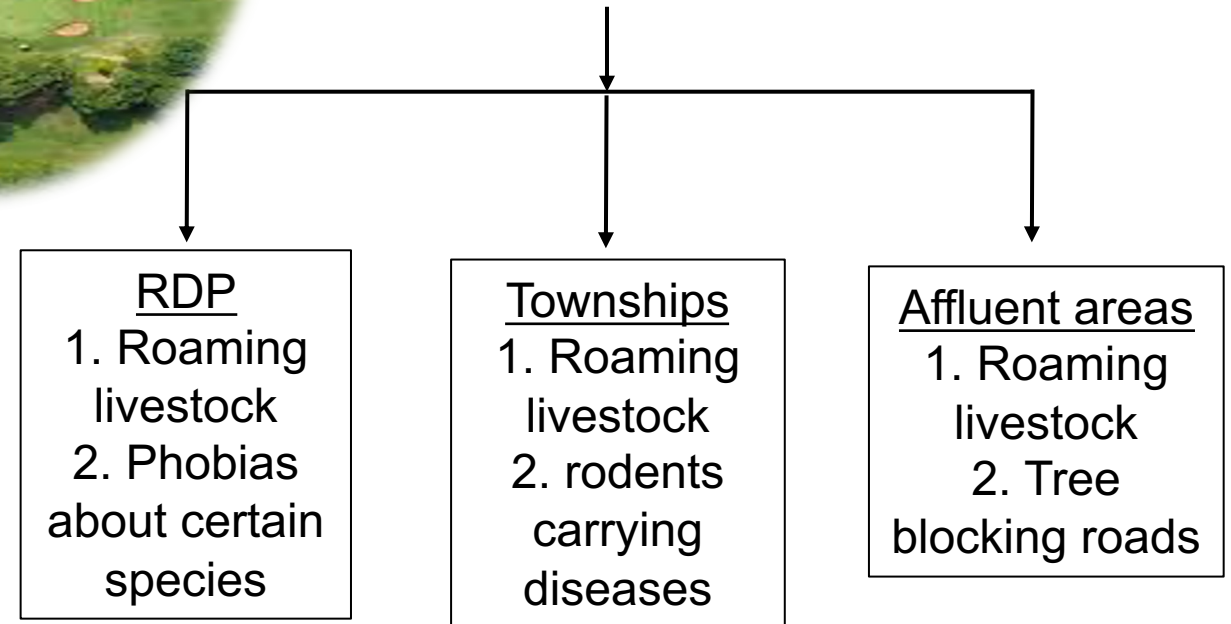*Nature and prevalence of ecosystem disservices (EDS) across urban areas*

Number of EDS/respondent: 0-12
Mean number significantly different between towns and neighborhoods within towns

- Gradient mean number EDS/respondent +

RDP   Township   Affluents

- Gradient mean number EDS/respondent +
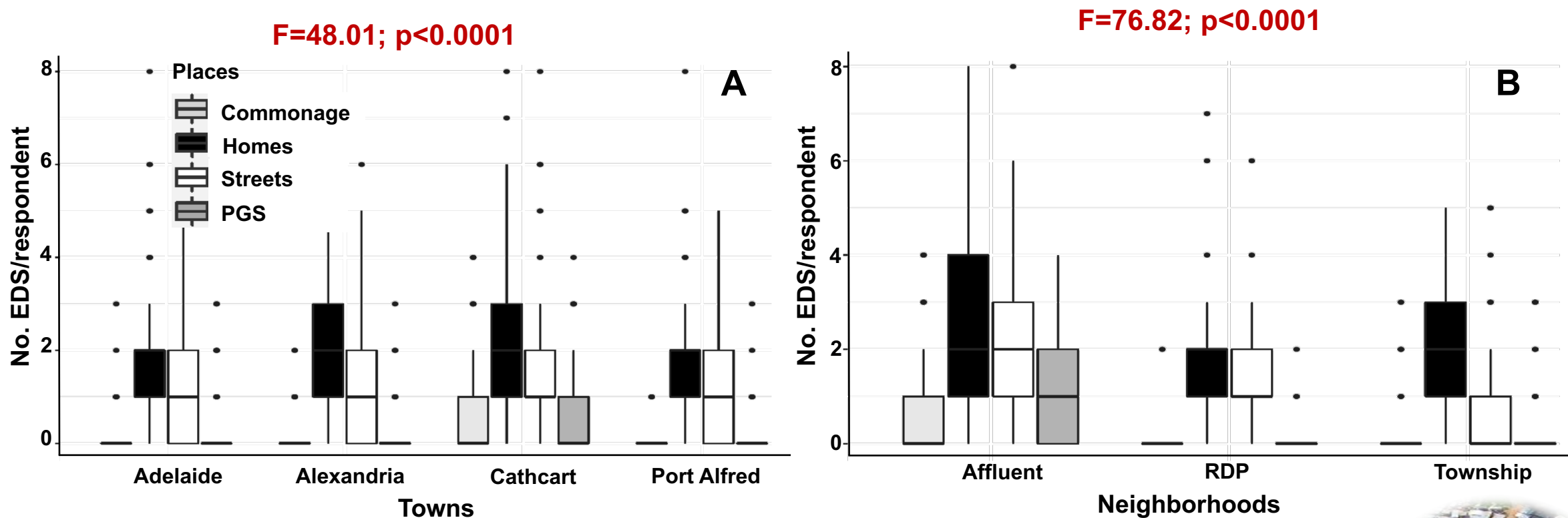
Port Alfred   Adelaide   Cathcart
Alexandria

Experience of EDS significantly neighborhood-dependent (p<0.05)

RDP
1. Roaming livestock
2. Phobias about certain species

Townships
1. Roaming livestock
2. rodents carrying diseases

Affluent areas
1. Roaming livestock
2. Tree blocking roads

Results and discussion

Figure 1. Number of EDS per respondent between places of experience, in relation to respondents' residence towns and neighborhoods.
PGS = Public Green Spaces; RDP = Reconstruction and Development Programme

Results and discussion

Experiences of EDS across urban areas and socio-economic strata

a. — **Gradient number EDS experienced by all respondents +**

Commonages · Public GS · Streets · Home Gardens

b. — **Gradient mean number EDS/respondent +**

Commonages/Public GS · Streets · Home Gardens

Trends in a and b are independent of respondent residence (i.e. town and neighborhood)

Experience of EDS significantly influenced by socio-economic and environmental factors ($p<0.05$)

No significant influences: town, years of residence, age, gender, upbringing, membership to environmental NGOs

− Gradient mean number EDS/respondent +

Socio-economic and environmental categories

- RDP	- Townships	- Affluent areas
- Xhosa	- Afrikaans	- English-speaking
- Lower education level	-	- Higher education level
- Lower income	-	- Higher income
- Social Grants and wages	- Private pension	- Biggest income from own business
- Potentially anthropocentric	-	- Potentially ecocentric

Results and discussion

Vulnerability to EDS and coping ability across urban areas and socio-economic strata

Vulnerability = Magnitude of experience + Coping ability

Vulnerability = EDS-specific

10 most reported EDS in three categories

| High magnitude, high coping ability	High magnitude, low coping ability	Low magnitude, High coping ability
Rodents carrying diseases, vegetation hiding criminals, phobias, plants damage, birds making mess, fallen leaves/Flowers/Fruits	Roaming livestock	Fallen branches, roots breaking pavements/walls, trees blocking roads

Significantly influences of socio-economic and environmental factors, except town and gender (p<0.05; r <0.50 in general, except 5 cases of r=0.50-0.69)

Results and discussion

Vulnerability to EDS and coping ability across urban areas and socio-economic strata

- Gradient of magnitude of experience +

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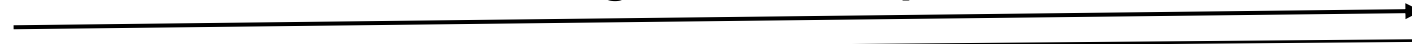
Socio-economic and environmental categories

- Membership environmental NGOs (e.g. birds making a mess, rodents carrying diseases)
- Ownership gardens (e.g. birds making a mess, rodents carrying diseases, roaming livestock, plants damage)
- English-speaking (e.g. rodents carrying diseases)
- Longer stay in a town (e.g. rodents carrying diseases)
- Rural upbringing (e.g. roaming livestock)

- Anthropocentric (e.g. birds making a mess, rodents carrying diseases)
- Affluent areas (e.g. Roaming livestock)
- Higher income (e.g. Roaming livestock)
- RDP (e.g. rodents carrying diseases, phobias, vegetation hiding criminals)
- Low income (e.g. rodents carrying diseases, phobias, vegetation hiding criminals)
- Higher education level (e.g. Roaming livestock)
- Biggest income from own business (e.g. Roaming livestock)
- Older (e.g. trees blocking roads)
- Visit to Green spaces (e.g. roots breaking pavements/walls)
- Visit less often/rarely (e.g. fallen leaves/Flowers/Fruits)

No significant influence on fallen branches

Results and discussion

Vulnerability to EDS and coping ability across urban areas and socio-economic strata

- Gradient of coping ability +

Socio-economic and environmental categories

- Potentially anthropocentric (e.g. birds making a mess, roaming livestock, fallen branches, plants damage)

- RDP
- Xhosa
- Lower education level (roaming livestock)
- Visit GS (Fallen branches)
- Visit GS less often/rarely (roaming livestock)
- No membership environmental NGOs (e.g. plants damage)

-

-

- Townships
Afrikaans

- Biggest income from own business (e.g. birds making mess, phobias)
- Higher income (e.g. fallen branches, phobias)
- Affluent areas (e.g. fallen branches, phobias, plants damage)
- English-speaking (e.g. fallen branches, plants damage, roots breaking pavements/walls, trees blocking roads, birds making mess)
- Ownership gardens (e.g. roaming livestock, trees blocking roads)
- Older (e.g. roots breaking pavements/walls)
- Urban upbringing (e.g. fallen branches)

No significant influence on fallen leaves/Flowers/Fruits, rodents carrying diseases, vegetation hiding criminals

Implications

2.1. Among ten EDS reported by more than 5% of respondents, **roaming livestock is the one of most concern** at both town and neighborhood scales

2.2. EDS such as hiding spaces for criminals, phobias, rodents carrying disease, plant damage, birds making mess and falling leaves/flowers/fruits **of lower concern and deemed relatively easily manageable**

Important to consider magnitude of experience and coping ability, and not just the prevalence of EDS to better guide policies around inclusion of EDS into GS management

1. Having more experiences of EDS reported in HGs and close-by streets suggests limited visit of public GS and commonages (Garekae & Shackleton, 2020; Manyani et al., 2021) :
- due to the lack of aesthetic appeal in these places because they are not well taking care of
- Due to geographical location making them unsafe places or good refuges to criminals

Hence, while important to develop more green and biodiverse spaces in less wealthier areas, it is necessary to properly plan strategies for efficient management and maintenance, something that is lacking in most small towns in South Africa (Gwedla & Shackleton, 2015)

Implications

3. Although more EDS in affluent areas than other neighborhoods, affluent residents are not the most affected or most vulnerable to EDS because of the financial resources and/or knowledge to do so (or hire somebody with the requisite knowledge to address the 'problem')

5. **Respondents' age and length of residence in neighborhoods** also key in determining vulnerability to specific EDS, either because of reduction in physical/visual ability or through acquisition of some adaptation ability to their environments over the years

4. Having HG, being ecocentric or member of environmental NGO, having rural upbringing and regular visits to public GS play important role in building a certain resilience towards and a coping ability to or acceptance of some of the less significant EDS (nuisances), such as birds or falling leaves making a mess

Further research would explore more in depth underlying mechanisms driving the variations in terms of the experience and vulnerability to EDS (e.g., access to resources, cultural perceptions), by including a wider range of potential EDS, particularly those related to psychological or social impacts.